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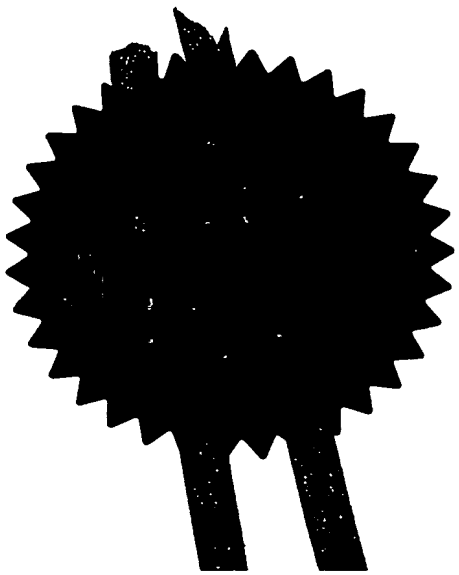

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Dated 5 October 2004

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010CT03 E841354-1 D02831
P01/7700 0.00-0322966.3

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

The Patent Office

Cardiff Road
Newport
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NP9 1RH

1. Your reference

57.0598 GB NP

2. Patent application number
(The Patent Office will fill in this part)

0322966.3

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

Schlumberger Holdings Limited

PO Box 71
Craigmuir Chambers
Road Town, Tortola
British Virgin Islands

Patents ADP number *(if you know it)*

723632600

If the applicant is a corporate body, give the country/state of its incorporation

British Virgin Islands

4. Title of the invention

SYSTEM AND METHOD FOR CORRECTING ERRORS IN DEPTH FOR MEASUREMENTS MADE WHILE DRILLING

5. Name of your agent *(if you have one)*

William L. WANG
Schlumberger Cambridge Research Limited
High Cross
Madingley Road
Cambridge CB3 0EL
UK

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

Patents ADP number *(if you know it)*

76261610

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*
USA	10/330,634	27/12/2002
USA	10/400,125	26/03/2003

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*

a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.
See note (d))

YES

Patents Form 1/77

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Continuation sheets of this form	–
Description	6
Claim (s)	2
Abstract	1
Drawing (s)	3 only

10. If you are also filing any of the following, state how many against each item.

Priority documents	–
Translations of priority documents	–
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	–
Request for preliminary examination and search *(Patents Form 9/77)*	1
Request for substantive examination *(Patents Form 10/77)*	1
Any other documents *(please specify)*	–

11. I/We request the grant of a patent on the basis of this application.

Signature (signed) Date 1 Oct 2003

12. Name and daytime telephone number of person to contact in the United Kingdom
William L. WANG,
01223 325268

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DUPLICATE

SYSTEM AND METHOD FOR CORRECTING ERRORS IN DEPTH FOR MEASUREMENTS MADE WHILE DRILLING

FIELD OF THE INVENTION:

The present invention relates to the field of measurements made during the drilling phase of a hydrocarbon borehole. In particular, the invention relates to an automated method for correcting errors in depth for such measurements.

BACKGROUND OF THE INVENTION:

During the drilling phase of the construction of a hydrocarbon wellbore, the length of the drillstring in the borehole is used to estimate the measured depth (or along hole length) of a borehole, it is assumed that the pipe is inelastic and therefore does not stretch. However, discrepancies in the length of the borehole estimated at surface during rig operations and the actual length of the borehole there may cause gaps or lost data, when the uncorrected depth is used with logs of data measured during with sensors mounted on the drillstring, such as LWD and MWD logs.

SUMMARY OF THE INVENTION:

According to the invention a method is provided for automatically correcting for depth errors in measurements taken from a drillstring comprising the steps of receiving data representing measurements taken in a hydrocarbon wellbore at a plurality of depths within

the wellbore from at least one sensor located on a drillstring used to drill the wellbore, automatically calculating corrections for errors in the depth of the locations, and making use of the measured data having the depths corrected.

BRIEF DESCRIPTION OF THE DRAWINGS:

Figure 1 shows a scheme for correcting depth for measurements made from a drillstring according to a preferred embodiment of the invention;

Figure 2 shows an example of data prior to correction according to a preferred embodiment of the invention; and

Figure 3 shows data that has been corrected according to a preferred embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION:

The length of the drillstring in the borehole is used to estimate the measured depth (or along hole length) of a borehole. According to the invention, the depth is corrected. For real drill strings the assumption that the drillstring is inelastic is not valid. The length of the drillpipe is a function of several parameters including temperature, pressure, and stress. According to the invention, corrections are calculated based on at least the stress on the drillstring. In particular, a correction is calculated based on the un-deformed length of the drillstring and the stress due to the buoyant drillstring weight, weight on bit and

frictional forces due to contact with the borehole acting along the length of the drillstring. Two of these parameters, friction factor and weight on bit vary depending on the rig operation and the drillers input at surface. According to the invention, a method is provided for correcting the measurement of depth at surface for these parameters. The corrected depth is then used to assign depths to data measured downhole.

Figure 1 shows a scheme for correcting depth for measurements made from a drillstring according to a preferred embodiment of the invention. According to a preferred embodiment of the invention the following steps are undertaken for each time step:

1) The drillstring description, dimensions pipe weight per unit length are input, the pipe length as measured at surface is updated from real-time measurements.

2) The borehole trajectory, inclination and azimuth are input and updated from downhole measurements in real-time.

3) The rig operation is computed preferably as described in co-pending US Patent Application Serial No. 10/400,125 entitled "System and Method for Rig State Detection," filed on 26 March 2003, which is a continuation-in-part of co-pending US Patent Application Serial No. 10/330,634 filed on 27 December 2002. Both of these applications are hereby incorporated herein by reference.

4) A model for computing the stress in the drillstring is given the operation is selected.

5) A friction factor is selected for the given rig state.

6) Weight on bit is either estimated from the hookload and total hookload or from weight on bit measured downhole.

7) From these inputs the model is used to compute the hookload. If the hookload is within tolerances equal to the measured hookload the stress profile is accepted and used to compute the pipe stretch. If it is not then the friction factor or the weight on bit are varied until the hookload and the calculated hookloads match. The models used here and in step 4 above preferably known models such as Drillsafe™.

8) Pipe stretch is then computed using the stress profile.

9) The stretch correction is applied to measured depth to give the corrected depth and time stamped.

10) Time stamped downhole data is the associated with the corrected surface measured depths with the same time stamp.

Figure 2 shows an example of data prior to correction according to a preferred embodiment of the invention. The first frame of Figure 2 shows a surface time verse depth plot, the first section is drilling without surface rotation. As a result all of the friction force is opposing the motion of the drillsting along the hole. As a result whilst drilling the direction of the friction force is towards surface. The driller then stops drill pulls the drillstring off bottom and then runs back to bottom rotating the drillstring, when rotating the

friction force opposes the direction of rotation and as a result the frictional force along the borehole falls to close to zero. This results in an increase in the tension in the pipe and therefore an increase in the pipe stretch as a result the position of the bottom of the hole as measure from surface appears shallower. In the second frame the resistivity data are shown plot against the same time scale. In the third frame the resistivity data are plotted against the apparent depth at which they were measured. It can be seen that there is a section of data in lighter grey that in terms of depths overlaps previously recorded data. Conventionally, these data would be discarded. The darker line represents the data that would be kept. Thus, failure to compensate for errors in depth results not only in lost data but also the thickness of the formation section appearing thinner.

Figure 3 shows data that has been corrected according to a preferred embodiment of the invention. The stress profile and the pipe stretch have been calculated according to an appropriate model for the rig operation. Note that in the first frame, the depth at which drilling resumes is very close to the depth at which it stopped. Secondly, the measured resisitivities are properly allocated to the measure depth. Thus, according this embodiment of the invention, there is no loss of data or gaps, (the remaining grey points are recorded off bottom).

While the invention has been described in conjunction with the exemplary embodiments described above, many equivalent modifications and variations will be apparent to those skilled in the art when given this

disclosure. Accordingly, the exemplary embodiments of the invention set forth above are considered to be illustrative and not limiting. Various changes to the described embodiments may be made without departing from the spirit and scope of the invention.

CLAIMS

What is claimed is:

1. A method for automatically correcting for depth errors in measurements taken from a drillstring comprising the steps of:

receiving data representing measurements taken in a hydrocarbon wellbore at a plurality of depths within the wellbore from at least one sensor located on a drillstring used to drill the wellbore;

automatically calculating corrections for errors in the depth of the locations; and

making use of the measured data having the depths corrected.

2. A method according to claim 1 wherein the step of automatically calculating the corrections is based at least in part on the state of a drilling rig used to support the drillstring at the times when the measurements are taken.

3. A method according to claim 1 wherein further comprising the step of measuring the length of portions of the drillstring prior to insertion into the wellbore.

4. A method according to claim 3 wherein a time versus depth log is constructed using at least the measured length of portions of the drillstring.

5. A method according to claim 4 wherein the calculated corrections is applied to time versus depth

log to generate a corrected time versus depth log, and wherein the corrected time versus depth log is combined with the data representing measurements taken in the wellbore such that a corrected depth can be attributed to said measurements.

6. A method according to claim 1 wherein said step of calculating corrections is based in part on estimates of stretch of the length of the drillstring.

ABSTRACT

A method and system is disclosed for automatically correcting for depth errors in measurements taken from a drillstring during the drilling phase of the construction of a hydrocarbon wellbore. The correction is based on a stress profile which in turn is based on the the states of the drilling rig, drill string description length spec, borehole description trajectory, friction factor and weight on bit.

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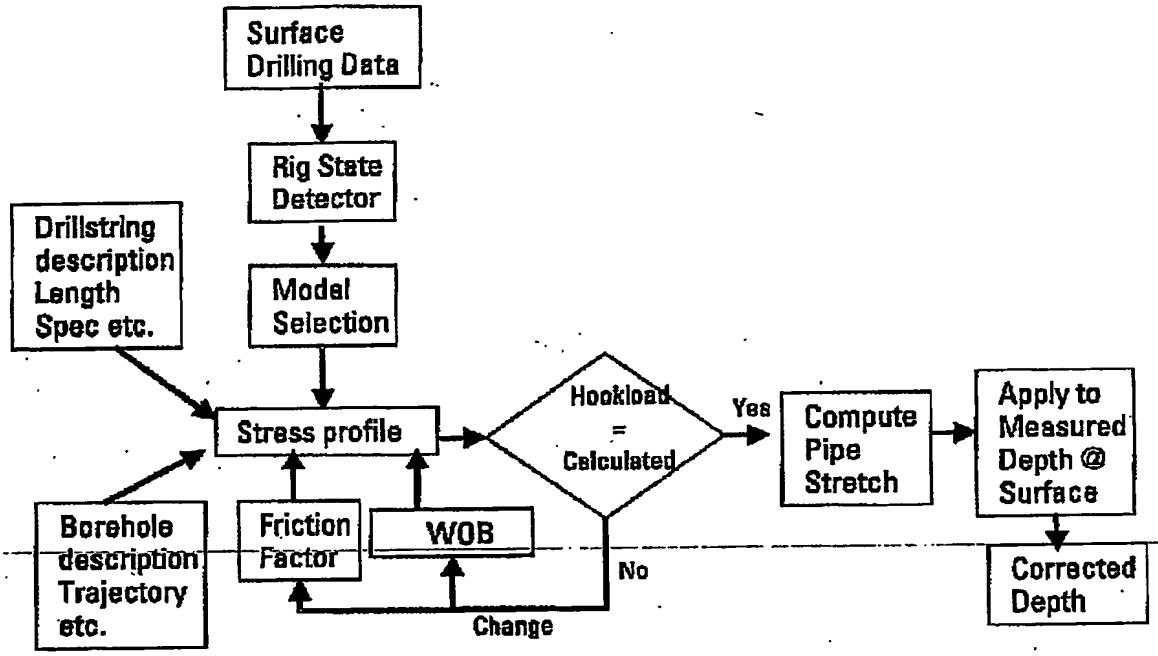

Figure 1

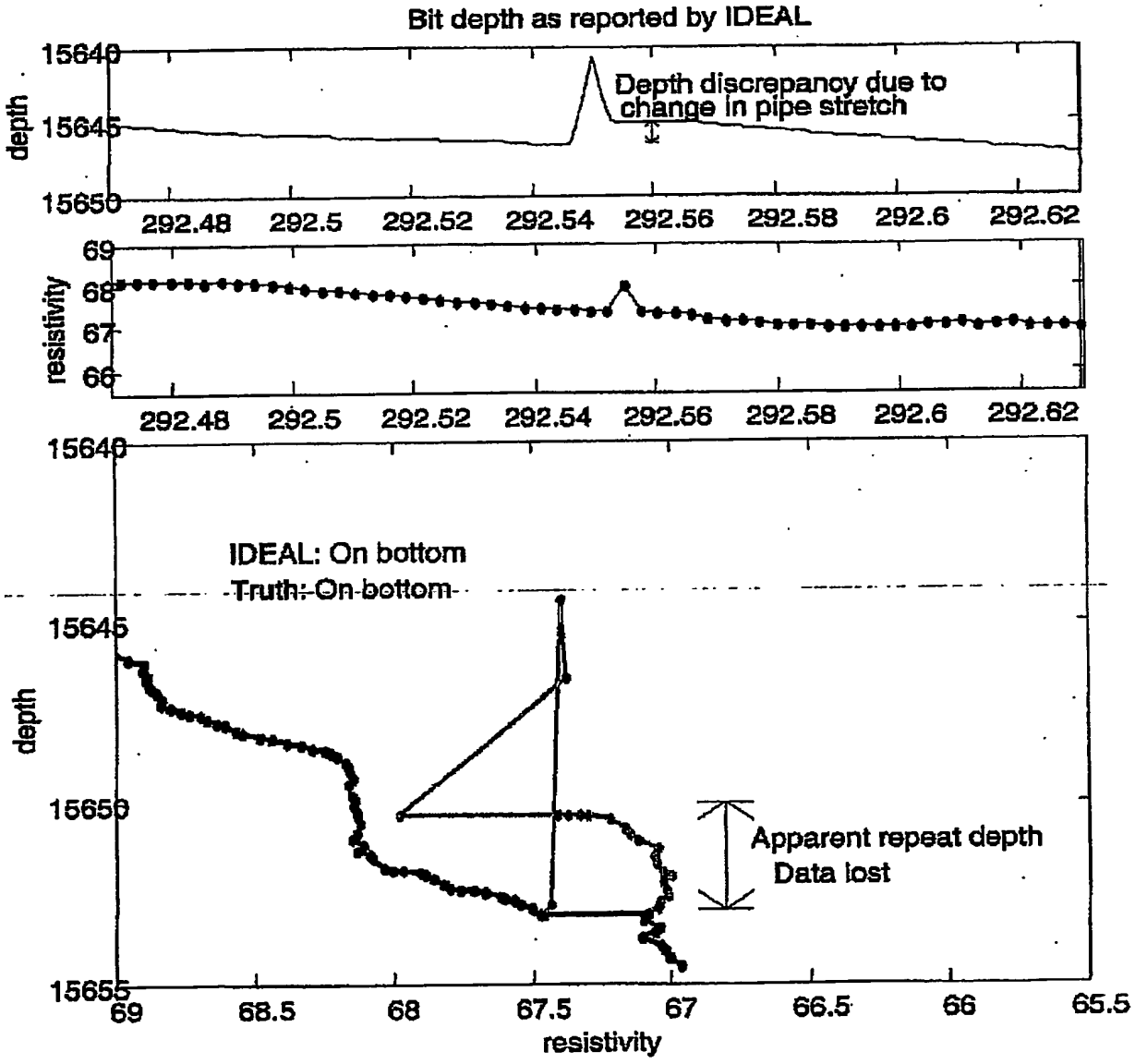
Bit depth as reported by IDEAL
depth
15640
15645
15650
Depth discrepancy due to change in pipe stretch
292.48
292.5
292.52
292.54
292.56
292.58
292.6
292.62
resistivity
69
68
67
66
IDEAL: On bottom
Truth: On bottom
15655
Apparent repeat depth
Data lost
68.5
67.5
66.5
65.5
resistivity

Figure 2

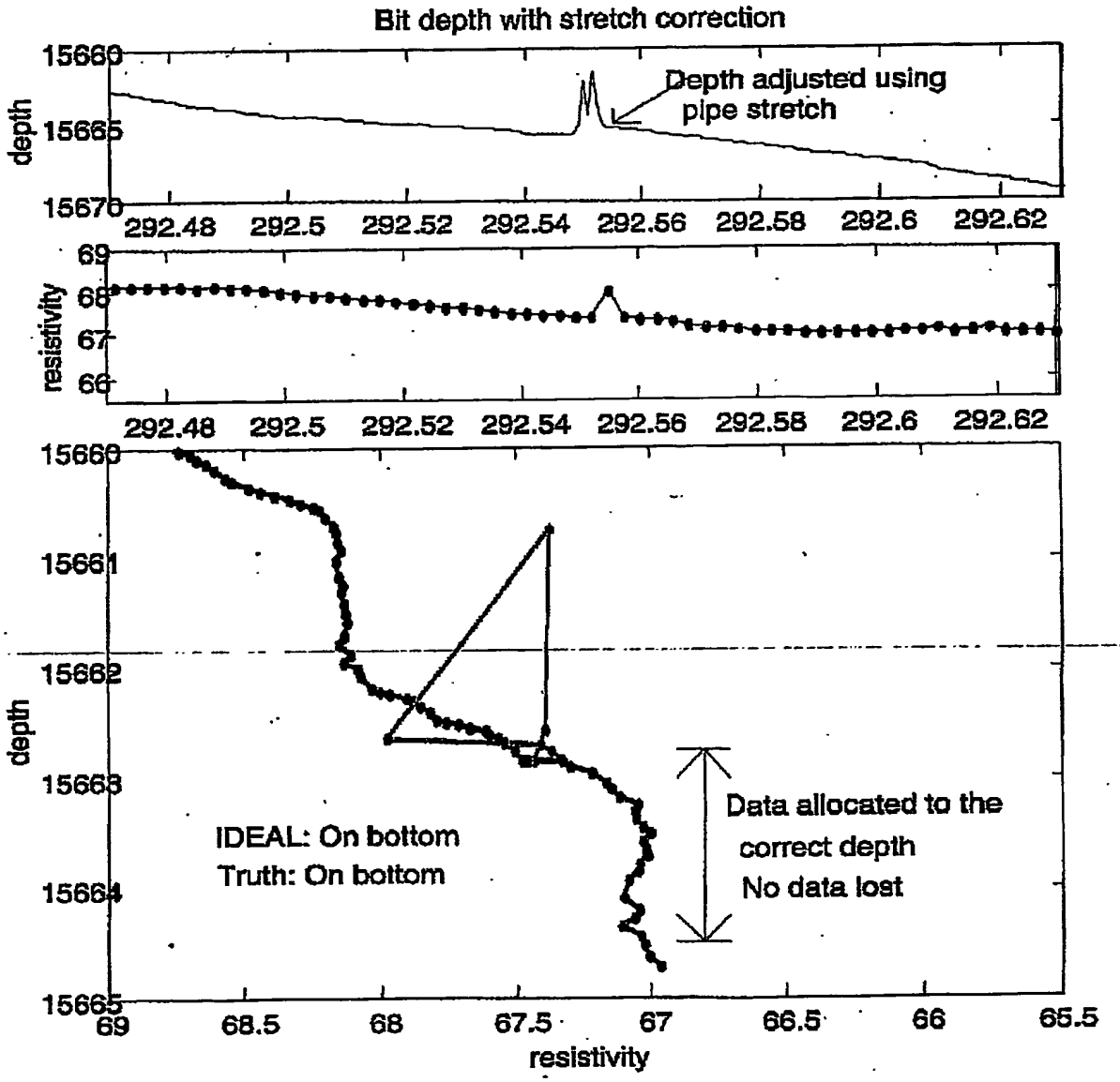
Bit depth with stretch correction
depth
15660
15665
15670
Depth adjusted using
pipe stretch
292.48
292.5
292.52
292.54
292.56
292.58
292.6
292.62
resistivity
69
68
67
66
15660
15661
15662
15663
15664
15665
IDEAL: On bottom
Truth: On bottom
Data allocated to the
correct depth
No data lost
69
68.5
68
67.5
67
66.5
66
65.5
resistivity

Figure 3